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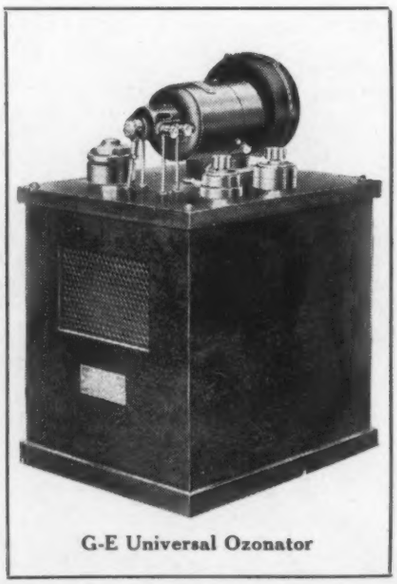

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POWER AND GAS
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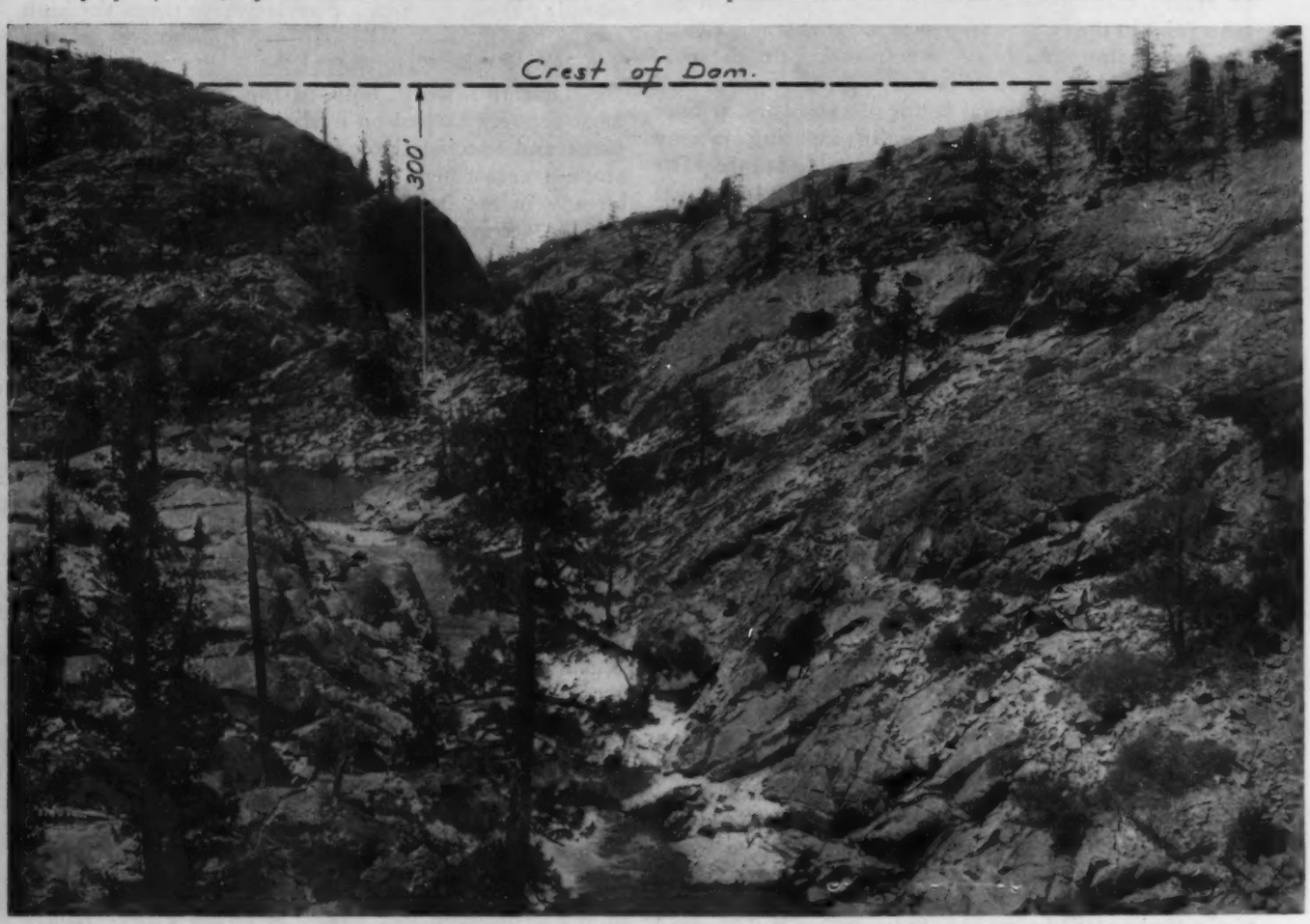
BEAR VALLEY HYDROELECTRIC DEVELOPMENT

BY JAMES H. WISE.[1]

The hydroelectric project on the south fork of the Yuba and Bear Rivers has been in contemplation for some time, but active work was not begun until permission was received from the Railroad Commission on July 3, 1912, by the Pacific Gas & Electric Co. at Lake Spaulding. The water thus stored is to be diverted, together with the natural run-off, to the Bear River water shed, conducting it in tunnels and canals along the south side of the Bear River Canyon to a point about three miles northeast of Towle Station on the Southern Pacific, to a regulating reservoir known as the "Drum Forebay." Two riveted steel pipe lines will lead from this reservoir to the power house 1350 ft. lower in elevation, and situated on Bear River, where an installation of 40,000 kilowatts, consisting of four units, will be erected, together



View of the Dam-Site from Up-Stream, Showing the Elevation to Be Reached by the Waters of the Lake.

The development makes use, for power purposes, of the water already impounded in twenty reservoirs in the catchment area of the South Yuba, having a capacity of 2,024,000,000 cu. ft., combined with additional storage of 4,000,000,000 cu. ft., to be secured

[1]Assistant General Manager Pacific Gas & Electric Co.

with the necessary transformers, exciters, governors, and other adequate equipment to make the entire installation complete. Electric power from this plant will be transmitted at 115,000 volts on a double circuit steel tower line, extending in a southwesterly direction via Nicolaus to Cordelia, the load center of the Pacific Gas & Electric Company. At this point step-down transformers will be used for reducing the pressure to approximately 60,000 volts, permitting the power thus to be transmitted to various parts of the system: Oakland, Berkeley, Alameda, San Rafael, Santa Rosa, Vallejo, Petaluma, and northward toward Suisun, Cement, Woodland, Sacramento, Davis, Dixon, and, in fact, to any part of the vast territory already covered by the 60,000-volt network of transmission lines.

The project further includes the construction of a steel tower line from Cordelia to San Rafeal, Sausalito and Lime Point, thus providing Pacific Service to the Marin peninsula and the transmission of hydro-electric power ultimately to San Francisco.

Adverting to Lake Spaulding, this splendid reservoir site, with a capacity of 4,000,000,000 cu. ft., or nearly double the combined capacity of all of the reservoirs in the South Yuba system, will be formed by the construction of a huge monolith of cyclopean concrete. The dam will be of gravity type section, arched upstream for an additional factor of safety and a more substantial type of construction, thus insuring stability and absolute security against any possible failure. The dam will be 300 ft. in height and will be built somewhat similar to the New Croton and Croton Falls dams of the New York Water Supply, and of cross section, approximating the Roosevelt Dam, which impounds such a vast quantity of water for the Salt River project, a part of the reclamation work of the United States Government. The reservoir is situated about two miles northeast of Smart Station, on the Southern Pacific Railroad, at an elevation of 4,600 ft. The proximity of the site to the main line of the Southern Pacific is indeed fortunate and a spur track directly to the location of the dam will greatly facilitate and economize the work. This track has already been constructed and work on the cableways, sand and gravel bunkers and tunnel outlet is now rapidly progressing.

In connection with this work at Lake Spaulding, not the least important is the operation of the old Birce & Smart sawmill, now owned by the Pacific Gas & Electric Company. The high dam will flood 700 acres of land which now contains over 1,000,000 board ft. of standing timber, which the mill has been converting into ties, boards and dimension stuff at the rate of from twenty to thirty thousand board ft. of lumber per day. There is already a good stock of lumber on hand for the work as it progresses. The clearing of the reservoir site will therefore be practically completed and, at the same time, a most valuable use of the timber will be made. Any surplus will be used in the maintenance and repairs of the many flumes on the South Yuba system. A solid rock concrete-lined tunnel, 4427 ft. long, will form the reservoir outlet and will conduct the water to the upper end of a concrete-lined canal 8½ miles in length, having a capacity of 400 second ft., or 16,000 miners' inches. This canal will contain no flumes but will have a short syphon near the lower end leading to the forebay previously mentioned. The regulating reservoir site is a large flat area capable of being converted into a forebay of 400 acre ft. capacity without excessive cost, and will thus provide sufficient water to run the entire plant for twenty-four hours, and will amply provide for peak load and other power fluctuations—a most valuable adjunct to a plant of this size and importance.

The forebay will be constructed by excavating the earth and loose material from the basin, forming a dam about 35 ft. in height on the south or lower side of the slope. The earth embankment will be made according to the most approved methods, namely, by placing the material in thin layers, thoroughly dampening, rolling and compacting, thus making the dam absolutely impervious. Two riveted steel pipe lines leading from this regulating reservoir will be 6300 ft. long and 72 inches in diameter at the upper end. The lower end will be provided with "Y" branches, castings and suitable gates and nozzles for conducting the water to the eight water wheels, each with a capacity of 9000 horsepower. The pressure at the nozzle of the 7-inch stream impinging upon the water wheel buckets will be 585 pounds per square inch, or nearly three times the high steam pressure used by the big locomotives of the Southern Pacific Company.

That this work, both in the field and office, is most actively carried on is shown by the fact that the plans and specifications of the water wheels, generators, transformers, steel towers, and pipe lines are already in the hands of the manufacturers, and bids will be received by the time this magazine goes to press. Excavation for the power house foundations began immediately upon securing the necessary permission from the Railroad Commission, and camps were established along the canal line from the Lake Spaulding Dam to the forebay. At the power house sites at this time 1400 men are busily engaged in clearing, excavating and carrying on the many phases of work necessary to a project of this kind, while the engineers of the company have been for months preparing all necessary details, plans and specifications for each and every individual part of the equipment for the necessary prosecution and construction of the work, as well as the large units which will be used in the final operation of the completed plant. The canal line for its entire length has already been cleared of all brush and trees, and excavation is actively in progress. The forebay site has been cleared of all loose material and objectionable surface earth which could not be used in the main body of the embankment, and some three hundred head of stock and one hundred and fifty men are now actively carrying on the excavating and placing of the earth for the embankment.

Preliminary and final surveys and many of the rights-of-way have been already secured for the 118-mile transmission line from the Drum Power House to Cordelia, and work on the foundations for this line will begin within a few weeks, so that the towers can be installed, assembled and erected in the early spring of 1913, thus insuring and guaranteeing completion of the line before the fall of next year, which will witness, without doubt, the final completion of the entire project.

Looking Toward the Dam-Site from Up-Stream.

THE SPAULDING DAM.

BY HERMANN SCHUSSLER.

Recently it was my good fortune to accompany Mr. J. A. Britton, vice president and general manager, and Mr. J. H. Wise, assistant general manager, of the Pacific Gas & Electric Company, to the site of the large storage reservoir which the company proposes to construct on the site of the old reservoir there, known as "Lake Spaulding."

The dam will be located a short distance down stream from Lake Spaulding; and, owing to its contemplated height of 300 ft. above the bed of the river, the original reservoir will be entirely submerged. While the length of the proposed dam will be only 60 ft. at the bottom of the gorge, its length along the finished curved top, will be 900 ft.

The reservoir to be created by the erection of the new dam will have a surface area of about 700 acres, and a storage capacity of 4000 million cu. ft. or 30,000 million gallons.

The watershed directly tributary to the reservoir has an area of fully 120 square miles with an average annual rainfall of between 60 and 70 inches.

Owing to the generally rocky and precipitous character of the water shed, the percentage which the seasonal surface run-off bears to the gross precipitation on the watershed will be fully 50 per cent.

Thus, the average, annual water product discharging from the above watershed into the proposed new Lake Spaulding will be equal to fully 8000 million cu. ft. or 60,000 million gallons, or double the storage capacity of the proposed reservoir.

By the construction of the proposed main concrete dam across the gorge of the South Yuba, the water surface of the proposed storage reservoir will be raised to such a height that it will be necessary to construct at two points of the divide on the northerly side of the lake two separate, comparatively low concrete dams. One or both of these, will be so arranged that they will form capacious waste-weirs, or spillways, for such waters as will have to be wasted from the reservoir when the latter—during or immediately after the snow-melting season—has been filled to its utmost capacity. By the construction of these spillways the necessity of discharging such waste-waters over the top of the high main concrete dam will be avoided.

The hydrographic features, thus briefly outlined, show that the reliability and constancy of the water supply from this source will be practically ideal.

In fact, I should be very much tempted—in spite of the already great height of 300 ft. of the contemplated main dam—to still further increase the same, in order to bring the storage capacity more nearly up to the average annual water product of the tributary watershed—if it were not for the necessity of having also to raise at considerable cost the two above mentioned subsidiary lower spillway-dams.

The ideal location of the proposed main dam in the precipitous narrow gorge of the Yuba, with its practically homogeneous rock bluffs on both sides of the river, fully excuses and justifies my above expressed desire of increasing the height of the dam above the contemplated height of 300 ft.

When, about seven years ago, I stood—like last week—on the rock bluff, the main body of which will form the southerly abutment of the proposed arch-shaped dam, I could not help feeling and expressing delight at seeing one of the most admirably formed dam sites, that I had ever beheld—admirable both from a topographical as well as geological point of view.

The dam, in all probability will be built with the system of interlocking, keystone-shaped concrete

blocks—built in place alternately—containing not less than 400 cubic yards each—and similar to the dam built by me in San Mateo County, where it forms the large Crystal Springs Reservoir of the Spring Valley Water Company. This same method was successfully employed in the construction of the large Barren-Jack dam in Australia.

The successful manner in which the above main Crystal Springs concrete dam resisted the tremendous wrenching to which it was subjected by the earthquake of April 18th, 1906—although located close to the main fault-line—fully proved that the method of construction adopted by me, coupled with the first-class materials and thorough workmanship employed in its erection, fully justified the great care bestowed upon every portion of this important work.

The rock required for the concrete for the new Lake Spaulding dam—estimated at between 250,000 and 300,000 cubic yards of concrete—will be quarried out of or near the bluff over-topping the southerly abutment of the same, while the necessary gravel and sand is found of excellent sharp-grained quality and in great abundance, in a large nearby moraine—a remnant of the glacial period.

The successful construction and completion of the proposed new concrete dam for the greater Lake Spaulding—owing to its height as well as its great economic value for developing the resources of our state, will not only reflect credit upon the company that had the foresight and boldness to undertake this magnificent work—but also upon the engineering talent employed in its conception, design and successful construction.

NATURAL GAS AUTOMOBILE.

The successful use of natural gas as a motive power was recently demonstrated by A. M. Schenck of Wheeling, W. Va., with a natural gas driven motor on the streets of Pittsburgh. A gasoline tank was provided as a reserve and it was possible to shift from one fuel to the other without loss of time and while the car was running, by means of a small lever at the side of the driver's seat.

The gas is carried in three pressure bottles, each containing 140 cu. ft. at 1500 lb. pressure, from which it is brought down in one step to 100 lb. pressure. From this point it passes through a regulator, then into a device corresponding to a carburetor, at a pressure of only two ounces above gauge or atmospheric pressure. At this point the gas is mixed with air, and the mixture is drawn into the engine on the suction stroke.

There is an important difference between this and the gasoline system, for which economy is claimed, —the gas contains approximately 23,000 heat units as against 18,000 for good gasoline.

The equipment department of the American Can Company in a report filed with that company presented the following cost figures:

Number of ft. natural gas used per mile, 12½.
Cost of gas and compressing, 50 cents thousand ft.
Cost per mile, .0065.
(Estimating that one gallon gasoline will run truck 6 miles).

Cost of gasoline per gallon	.20
Cost per mile	.0333
Cost per mile, gasoline	.0333
Cost per mile, natural gas	.0065
Saving per mile	.0268

COST OF ELECTRIC PUMPING PLANTS IN BRITISH COLUMBIA.

BY B. A. ETCHEVERRY.[1]

First Cost of Plant.

The first cost of a pumping plant depends on the grade of machinery, the cost of transportation, the expense of installation. Because of these factors accurate estimates of cost can not be given. However, the approximate cost values given below will be of value to the land owner who is considering the feasibility of a pumping plant. The values given represent the prices at Vancouver and do not include transportation and installation.

Approximate Cost of Single Stage Centrifugal Pumps.

No. of pump.	Capacity in U. S. gallons per minute.	Cost
2	100	$ 70
2½	150	85
3	225	95
3½	300	110
4	400	120
5	700	140
6	900	190
7	1200	240
8	1600	285

The cost of two step centrifugal pumps of the same sizes will be about four times the values given above.

Approximate Cost of Triplex Single Acting Power Pump.

Diameter of water cylinder.	Length of stroke in inches.	Capacity in U. S. gals. per minute.	Height of lift.	Cost.
4	8	65	75 to 100 ft.	$ 270
5	10	130	"	400
6	12	220	"	550
4	6	48	175	300
5	8	91	"	440
7	8	180	"	600
8	10	270	"	950
8	12	310	"	1000

Approximate Cost of Electric Motors, Gasoline Engines and Simple Slide Valve, Non-condensing Steam Engine, With Locomotive Boiler and Auxiliaries.

Horse Power	Cost of electric motors. 1200 rev. per minute.	Cost of gasoline engines.	Cost of steam engines.
2	$ 90	.....	.....
3	110	.....	.....
5	160	$ 475	$ 650
10	260	725	800
15	280	900	1,000
20	340	1,100	1,200
30	410	1,600	1,500
35	410	1,600	1,500
40	...	2,100	1,700

Cost of Accessories and Installation.

The above costs are for the pumps and engine and do not include the accessories, the foundation, the labor of installation, and the housing. For an electric plant the cost of transformers should be added unless these are supplied by the electric company. The accessories will include the suction and discharge pipes, the valves and fittings, the priming pump, the connection between pump and engine. The suction pipe is usually made of steel; the discharge pipe may be steel or wood banded pipe and should cost delivered at different points in the arid part of British Columbia about as follows:

Cost of Pipes Safe for 150 Feet Head.

Diameter of pipe.	Cost per foot of wood banded pipe.	Cost per foot of steel pipe.
4 inches	$ .20	$ .30
6	.30	.50
8	.40	.80
10	.55	1.10
12	.65	1.35
14	.75	1.60
16	.95	2.00
18	1.10	2.50
20	1.44	3.00

For a rough estimate the total cost of valves, priming pump, all fittings and suction pipe, but not discharge pipe, may be taken as about 10 per cent. of

[1]Head of Department of Irrigation, University of California.

the cost of pump and engine for a gasoline or steam plant and 20 per cent for an electric plant. The cost of installation should not exceed 5 per cent. The cost of a building to house the plant will range from about $25 for a small plant to $100 or more for a larger plant. The cost of transportation and hauling will depend on the railway charge from Vancouver and on the distance from the station to point of installation.

Fuel Consumption and Fuel Cost.

The selection between a steam engine, gasoline engine and an electric motor will depend to some extent on the comparative cost of coal, gasoline, and electrical energy.

A gasoline engine is usually guaranteed for a fuel consumption of 1-9 to 1-10 of an Imperial gallon of gasoline per rated or brake horsepower per hour. A new engine well adjusted will come up to this efficiency, but an engine that has been operated some time will consume about 1-7 of an Imperial gallon of engine gasoline or distillate per brake horsepower per hour.

The fuel consumption of a steam engine will vary greatly on the type of boiler and engine. A small slide valve non-condensing engine under 25 h.p. will use probably 50 to 60 lb. of steam per brake horsepower per hour. A locomotive type of boiler should give 5 or 6 lb. of steam for 1 lb. of coal. Therefore, a small steam engine under 25 horsepower should consume about 10 lb. of coal per brake horsepower per hour. Steam engines of the same type from 30 to 50 horsepower will consume from 5 to 8 lb. of coal per brake horsepower per hour.

Electrical energy is measured in kilowatts. A kilowatt is equal to 1 1-3 horsepower, but because of the loss of energy in the motor, 1 kilowatt will usually give about 1.1 brake horsepower. Based on this figure 1 brake horsepower hour is equal to 9-10 of a kilowatt hour.

The above values show that to produce 1 brake horsepower per hour, it requires either 1-7 of an Imperial gallon of distillate, about 10 lb. of coal, or 9-10 of a kilowatt hour. Based on these figures the table below shows the cost of fuel per brake horsepower per hour for several equivalent cost values of fuel. In the table is also given the fuel cost of pumping one acre foot of water through a lift of one foot, assuming plant efficiency of 50 per cent and 75 per cent.

Equivalent units costs of fuel.			Fuel costs (in cents).		
Cost of gasoline in cents per Imp. gallon.	Cost of coal in dollars per ton (2,000 lb.)	Cost of electricity in cents per K. W. hour.	Per brake h. p. per hour in cents.	Per acre foot of water lifted 1 foot high. 50% efficiency.	75% efficiency.
14	$4.00	2.25	2.0	5.5	3.65
16	4.55	2.50	2.30	6.3	4.20
18	5.15	2.85	2.55	7.0	4.70
20	5.70	3.20	2.85	7.8	5.25
22	6.30	3.50	3.15	8.65	5.75
24	6.85	3.80	3.45	9.5	6.30
26	7.40	4.15	3.70	10.20	6.80

The price of engine gasoline bought in drums is about 24 cents per gallon delivered at Kamloops and 26 cents per gallon at Okanagan points. These prices are equivalent to coal at $6.85 to $7.40 a ton or electricity at 3.80 to 4.15 cents a kilowatt hour. The fuel cost is, however, only a part of the total cost of pumping.

Fixed Charges and Attendance.

A.—Fixed Charges.

The cost of installation represents a capital which if invested would bring in an income represented by the interest. It is therefore necessary to consider this interest as part of the cost of operation. To this should be added the annual cost of repairs, maintenance and renewal. These items of cost represent the fixed charges. After 6 or 8 years a gasoline engine may need to have its cylinder rebored and a new piston provided, the cost of which is about one-fourth the cost of a new engine. With ordinary care the life of a gasoline engine may be taken as 10 years; the life of an electric motor about 15 to 20 years. The fixed charges on the entire plant may be taken as follows:

Fixed Charges.	Gasoline engine plant.	Electric plant.	Steam engine plant (small).
Depreciation and renewal...	8 per cent	5 per cent	8 per cent
Repairs and maintenance....	3	1	2
Interest	6	6	6
	17	12	16

B.—Attendance.

An electric motor requires a minimum of attendance, small gasoline plants require frequent inspection, and steam engines require a licensed engineer and for that reason can not be economically used for small plants operated during short periods. The cost of attendance for an electric motor pumping plant should not exceed 5 cents per hour, for a gasoline engine plant 10 cents per hour and for a steam engine plant 40 cents per hour. While electric motors and gasoline engines are usually operated by the orchardist or irrigator, his time is valuable and a charge should be made for it.

Final Selection of Type of Plant.

The final selection of a pumping plant should be based on a careful consideration of the factors stated above. The best size of plant, the period of operation, the kind of engine or driving power, can only be correctly determined by a final consideration of cost of installation and cost of operation. For small plants operated for short periods during the irrigation season steam engines are not to be considered even where coal is cheap because they must be operated by a licensed engineer whose salary would be excessive in proportion to the saving obtained by using cheap coal. Where electric power is available the choice is between a gasoline engine and an electric motor. The electric motor requires minimum attendance, it is reliable and its first cost is much less than that of a gasoline engine. For these reasons if electric power is available, an electric motor is preferable to a gasoline engine and will prove far more economical than a gasoline, even should the cost of electrical energy be higher than the fuel cost for a gasoline engine, which is not likely to obtain in British Columbia because of the high cost of engine gasoline or distillate.

At Grand Forks, British Columbia, electricity was sold for pumping plants at the rate of 3 cents per kilowatt hour; as far as fuel cost is concerned this is equivalent to gasoline at about 19 cents a gallon. This is less than the cost at which gasoline can be obtained and in addition gives the advantages stated above.

The application of the above information and cost data to any particular case is illustrated by the following examples:

First example: A 20 acre orchard is to be irrigated by pumping. The quantity to be applied is 6 inches per month and the total depth in one season, 18 inches. The lift is 50 ft. and the discharge pipe 200 ft. long. Engine gasoline costs 24 cents per Imperial gallon. Assuming the pump is operated 1-3 of the time or ten twenty-four hour days each month, this will require a pump capacity of 225 gallons per minute, which is obtained with a No. 3 centrifugal pump and 7 horsepower engine. The discharge pipe will be 4 in. in diameter. The first cost and total cost of operation will be about as follows:

First Cost of Plant.

No. 3 centrifugal pump	$ 95
7 H. P. gasoline engine	600
Priming pump, suction pipe, fittings, etc	70
Freight charges and hauling	30
200 feet of 4-inch wood banded discharge pipe	80
Installation, 5% of cost	40
Building to house plant	40
Total cost	$955

Total Annual Cost of Operation.

Fuel cost of 7 brake H. P. engine for 3 periods of 10 days each or 720 hours is equal to 720x7x3.45—17,000c or	$170
Fixed charges at 17 per cent. of first cost	160
Attendance 720 hours at 10 cents	72
Total cost for 20 acres	$402
Cost per acre	$20.10

Where electric power is obtainable the first cost of plant and annual cost of operation for the same conditions, assuming the unit cost of electric power to be 3 cents per kilowatt hour would be:

First cost of plant	$530.00
Total annual cost of operation	245.00
Cost per acre	12.25

Tabulated below are the first costs of gasoline engine pumping plants and the costs of operation for orchards of 20, 40 and 80 acres for lifts of 50 ft. and 150 ft. and for different periods of operation. For the higher lift single acting triplex pumps are used. The costs given are based on gasoline at 24 cents a gallon, for a depth of irrigation of 18 in. for the lower lift and depths of 18 in. and 12 in. for the higher lift, it being assumed that by careful use of water, if the soil is retentive, 12 in. may be sufficient. The discharge pipe is assumed to be 200 ft. long.

Cost of Pumping With Gasoline Engines and Centrifugal Pumps for 50-Foot Lift, Gasoline 24 Cents a Gallon.

Area in Acres.	Number of days operated per month.	Pump Capacity.	No. of Pump.	Horsepower of engine.	First cost of installation.	Annual Cost of operation per acre; 18 in. depth of water applied.			
						Fuel.	Fixed charges.	Attendance.	Total.
20	5½	400	4	12	$1,225	$ 8.25	$10.50	$1.90	$20.65
	10	225	3	7	955	8.75	8.10	3.60	20.45
	20	113	2	5	725	12.00	6.20	7.20	25.40
40	5	900	6	25	1,855	7.75	7.90	.90	16.55
	11	400	4	12	1,225	8.25	5.25	2.00	15.50
	20	225	3	7	955	8.75	4.10	3.60	16.45
80	10	900	6	25	1,855	7.75	4.00	.90	12.65
	22	400	4	12	1,225	8.25	2.60	2.00	12.85

Cost of Pumping With Gasoline Engines and Single Acting Triplex Pumps for 150 Foot Lift.

Area in Acres.	Number days per month.	Capacity.	Horsepower of engine.	First cost of installation.	Annual Cost of operation per acre for a depth of irrigation water of 18 inches.			
					Fuel.	Fixed Charges.	Attendance.	Total.
20	8.3	270	15	$2,370	$15.50	$20.00	$8.00	$38.50
	12.5	180	10	1,740	15.50	14.80	4.50	34.80
	25.0	90	6	1,280	18.75	10.90	9.00	38.65
40	13.25	340	18	2,760	15.00	11.70	2.40	29.10
	16.66	270	15	2,370	15.50	10.00	3.00	28.50
	25.0	180	10	1,740	15.60	7.40	4.50	27.50
80	26.5	340	18	2,760	15.00	5.85	2.40	23.25

The capacities of pumps, especially plunger pumps, and the sizes of engines, vary with the different makes, and for that reason the sizes given are not always obtainable, but sizes approximating these can be used in place.

The above cost estimates are only approximate. They are based on the conditions stated above and are not applicable to all cases because of the varying conditions which make the installation of nearly every pumping plant a special problem. The estimates are made for gasoline engines and are considerably higher than for electric motors. The first example showed that with an electric plant the cost of pumping was only 60 per cent of the cost with a gasoline plant. The tabulated values show the following interesting results:

1st. The cost per acre of pumping is much larger for a small area than for a large area.

2d. The cost per acre does not vary considerably with the period of operation, and in some cases a plant moderately large operating for a shorter period will cost less per acre than a smaller plant operating a longer period. This is due to the lower fuel cost obtained with the larger more efficient plant and the decreased cost of attendance for the shorter period of operation which overbalances the larger fixed charges. Even should the resulting cost be smaller for the smaller plant, the inconvenience due to pumping for a long period and the extra labor in irrigation may overbalance the saving in cost.

3d. For the lifts assumed a period of operation equal to about ten twenty-four hour days during the month or one-third of the time during the irrigation season seems to be preferable with the centrifugal pump. With the higher price triplex plunger pumps a period of operation of one-third to two-thirds of the time is preferable.

Co-operative Pumping.

The lower cost per acre for larger areas shows the advantages to be gained by co-operation between small owners. By uniting and installing a large plant instead of several smaller plants the cost of installation and operation is very much reduced and the plant can be given more competent attention which relieves the orchardist and increases the life of the plant.

Where by such co-operation several hundred acres can be brought together, a central steam plant to generate electric power, which is transmitted to the several electric motor pumping plants, is the most economical and best solution.

For separate plants above 20 or 40 horsepower, gas producer plants connected to gas engines will furnish the cheapest power. These plants are reliable and easily operated. They consist of the producer in which hard coal is placed and through a process of partial combustion, in presence of air and steam, forms the gas which operates the engine. Gas producers operated on hard or anthracite coal have been in successful operation for a number of years and those operated on soft or bituminous coal are coming into use, but have not been very successful. The fuel consumption is very low, usually from 1 to 1½ lb. of coal per horsepower for one hour, or ½ to ¾ of a cent per horsepower for one hour with hard coal at $10 per ton. This is from 5 to 7 times less than

the fuel cost with gasoline at 24 cents a gallon. Producer gas plants are more expensive than gasoline engines and for smaller plants the fuel economy will be overbalanced by the larger interest and depreciation charges. For very large single plants high duty steam engines will be the most economical form of installation.

Limit of Economical Pumping.

The cases previously worked out for gasoline engine pumping plants show that for small tracts of 20 to 80 acres the cost of lifting sufficient water to give a depth of irrigation water of 18 in. will range for a lift of 50 ft. from about $12.50 per acre for the larger area to about $20.00 per acre for the smaller area, and for lifts of 150 ft. the respective costs are about $23 and $35 per acre. These costs may seem high as compared with gravity water, but to obtain an idea of the economy and feasibility of developing water by pumping, comparisons must be made with the value of irrigation water in the irrigated districts of British Columbia and also in other localities under the same conditions. In British Columbia, up to the present, gravity water obtainable without pumping has been quite plentiful. For that reason pumping has not been necessary, and very few pumping plants have been constructed. However, water is becoming more valuable and the steps which many irrigation companies in British Columbia are taking to conserve water and prevent losses of transportation by carrying the water in concrete lined canals and in pipes constructed at considerable expense, show that water has become sufficiently valuable to justify pumping. If a comparison is made with water thus obtained, we find that the cost of construction of a well constructed system may go up to $50 or $60 an acre and even higher. This cost is charged up to the land which is sold to the orchardist and in addition reasonable profit is made on the value of the land. It is probably conservative to assume that land under an irrigation system will cost at least $100 an acre more than similar land for which there is no gravity supply. The chief advantage of gravity systems is the low annual cost of operation, usually less than $6 per acre, but if to this be added the interest on the difference in cost between land under the irrigation system and land which is to be supplied by pumping, assumed at $100, the total annual cost may be $10 to $15 an acre. This is about equal to the cost of pumping with gasoline engines to a height of 50 ft. and about half as large as for lifts of 150 ft. Where electric power is available or for large pumping plants the cost of pumping would compare very favorably with gravity water even for higher lifts than those stated above. There are many contemplated hydroelectric power installations in the irrigated regions of British Columbia which, if materialized, will be of great value in extending the area irrigated by pumping.

A consideration of pumping in other districts is of interest to show its feasibility. In eastern Washington water is being pumped in one case to an elevation of 250 ft. above the source of supply. In the citrus district of southern California lifts above 200 ft. are not unusual and it is considered profitable to pump 460 ft. In the Pomona district of southern California, the cost of pumped water averages $15 per acre for one acre foot when purchased from irrigation companies, while for smaller private plants the cost is often greater. In 1905 the Irrigation Investigations Office of the United States Department of Agriculture made tests on various pumping plants and these show that the cost of pumping at private plants of 10 to 100 horsepower with lifts of 100 to 300 ft. varied from $10 to $90 per acre for one acre foot of water.

There is a limit beyond which it is not economically feasible to pump. In the California citrus districts lifts above 400 ft. have been profitable. For the orchard lands of British Columbia equally high lifts should be profitable, for the net return per acre from a good apple orchard is usually more than that from a citrus orchard. A citrus orchard 10 years old should average a net profit of $100 to $150 per acre. The net profits from apple orchards 10 to 12 years old in the Yakima Valley are given in bulletins of the United States Department of Agriculture as $200 to $600 per acre. With profits larger than those obtained from citrus orchards in southern California, what has been considered feasible in pumping there is at least equally so for the apple orchards of British Columbia when no other more economical source of water supply is available. However, for small pumping plants and small areas the writer believes that it is well not to exceed 200 ft., while for larger plants lifts of 400 ft. may be economically feasible.

NEWS OF CALIFORNIA RAILROAD COMMISSION.

Applications.

Central California Gas Company to change authorized bonded indebtedness from $300,000 to $500,000, and to issue bonds in denomination of $1000 instead of $500.

San Diego Consolidated Gas & Electric Company, to issue $250,000 in bonds.

Board of Supervisors of Contra Costa County, to determine terms of overhead crossing, near Peyton.

Southern Pacific and Holton Interurban Railway, for approval of lease of track from El Centro west.

Big Four Electric Railway Company, to issue 100,000 shares of stock.

Answers.

Great Western Power Company, denying allegations of Pacific Telephone & Telegraph Company that its power line interfered with telephone lines between Napa and Sonoma.

Palo Alto Gas Company to city of Palo Alto, offering reduction in rate to $1.40 per 1000, or on sliding scale from $1.45 per 1000 to $1.25 per 1000 feet.

Pacific Telephone & Telegraph Company, to complaint of San Leandro Chamber of Commerce, denying inefficiency of service and discrimination.

Decisions and Orders.

Betts vs. Peoples Water Company, holding that water company should not divert water impounded for use of Claremont tract.

Northern California Power Company, holding that the company might issue $500,000 of 6 per cent debenture notes, on condition that it file stipulation to assess within eighteen months if directed by the Commission.

Los Angeles & San Diego Beach Railway Company, declaring passenger rates unjust and ordering reductions.

Indian Valley Electric Light & Power Company, allowing issue of notes of $65,228.

Mt. Konecti Light & Power Company, holding that company could operate in territory desired in Lake County without Commission's approval.

WESTERN LAWS OF ELECTRICITY AND WATER

The Desideratum in Legislation Regarding the Public Waters.

BY A. E. CHANDLER.

The legal principles governing the use of water are the result of judicial decisions rather than legislation. Just as the doctrine of riparian rights is the outgrowth of the old common law as interpreted by the English courts, so the doctrine of prior appropriation is the outgrowth of the customs of the pioneer miners and irrigators as interpreted by the Western courts. To continue to exist as common law a legal principle must be reasonably adapted to the time and the place. The strictly arid states long ago abrogated the doctrine of riparian rights because it was wholly unsuited to conditions there existing, and California has refused to follow the English common law rule of percolating waters for the same reason.

Riparian Rights.

The Western states still tolerating even a modified riparian doctrine are only semi-arid and naturally the older and larger cities are in the semi-humid section. It is therefore not strange that their supreme courts still find some virtue in the doctrine. Where irrigation is not the first aid to successful agriculture the riparian doctrine seems rational, and it would be at least unusual for one residing in a non-irrigated section and trained in the common law of the books to consider the doctrine of prior appropriation as other than a makeshift of frontier camps. During the last decade, however, irrigation has been given a tremendous impetus and the great size of the many projects undertaken in the semi-arid states has done much to show the unsuitability of the riparian doctrine.

The doctrine of prior appropriation on the contrary is proving more and more adapted to the needs of growing communities with restricted water supplies. The cardinal principle being reasonable use and the elimination of waste, no ditch is allowed to divert water unless there is actual immediate need for the use thereof. The popular notion of the exclusive ownership of water finds no authorization in the books. On the contrary expressions like the following show the attitude of the courts:

> It is the policy of the law that the best methods should be used and no person allowed more water than is necessary, when properly applied, and thus a larger acreage may be made productive by its extended application. *Little Walla Irr. Union v. Finis Irr. Co.—Ore.*—124 Pac. 668.

As an instrument of the best development the superior claims of the doctrine of prior appropriation is perhaps nowhere better shown than in the very recent case of Schodde v. Twin Falls Land & Water Company, decided by the Supreme Court of the United States on April 1, 1912, (32 Sup. Ct. Rep. 479). The plaintiff owns lands riparian to the Snake River in Idaho and by means of a number of water wheels, from 24 to 34 ft. in diameter, elevated the waters thereof to irrigate his lands. The defendant company by the construction of the Twin Falls dam and the consequent back water destroyed the current and rendered his wheels useless. If the doctrine of riparian rights were recognized in Idaho the remedy of the plaintiff would have been unquestioned, but the doctrine was long ago abrogated. The Supreme Court in affirming a judgment of dismissal quotes with approval the following words of the trial court:

> It is unquestioned that what he has actually diverted and used upon his land, he has appropriated; but can it be said that all the water he uses or needs to operate his wheels is an appropriation? As before suggested there is neither statutory nor judicial authority that such a use is an appropriation. Such a use also lacks one of the essential attributes of an appropriation,—it is not reasonable.

The opinion is but another illustration of the point that the doctrine of prior appropriation aims towards the highest use and greatest development, and is adapted to the time and the place.

Despite the weakness of the riparian doctrine, it is the accepted rule of property in the semi-humid states. As it has been fixed upon us by the courts, legislation attempting to abrogate it for lands now in private ownership, would be futile and should not be attempted. The suggestion has been made to lessen the statutory period now allowed a riparian owner in which to bring an action for wrongful diversion. It is a practical idea and worthy of adoption, but any change in the doctrine itself must be made by the courts.

Percolating Waters.

California is the only irrigation state which does not follow the common law rule that percolating waters belong to the owner of the soil. Excepting California there can be no need of legislation regarding the use of such waters.

In California the courts have departed from the common law and have laid down a new rule somewhat analogous to that of riparian rights in the surface streams. Under the new rule the owner of land overlying a body of percolating water is entitled only to a reasonable use of such upon his overlying land and may enjoin any diversion of such water to lands not overlying which will interfere with his reasonable use. Where a surplus exists, the court may fix the time and amounts for the pumping of percolating water to lands not overlying.

To be constitutional any legislation in California regarding percolating waters must be declaratory of the principles established by the courts. The scientific and technical questions which arise in the determination of the source and amount of percolating waters are so many and so difficult to positively answer, that few claimants will be satisfied with a determination not approved by the higher courts. Until administrative officers have demonstrated their efficiency in determining rights to the surface flow, there is little hope of them being given an opportunity to deal with percolating waters. At the present time the courts have established rules of their own which will conserve such waters, and those who are striving for better water legislation in California should concentrate their efforts in behalf of the surface supply.

Irrigation Versus Navigation.

As Congress has the superior right to legislate regarding the navigability of streams which may be used in interstate commerce, any conflict between the interests of irrigation and navigation rising out of the diversion of the waters of such streams cannot be anticipated and avoided by state legislation. In certain parts of the West, especially on the Colorado and Sacramento Rivers, the clash is imminent. As action by congress in favor of irrigation would be difficult to secure and of doubtful validity, the question must be settled by the communities involved. The investments in irrigation works and the industries dependent thereon are increasing each year, while other means for transportation are leaving little call for that by water.

As the War Department in order to maintain the navigability of a river may stop the diversions from the tributaries as well as from the main stream, it is clear that in most cases the material wealth of whole counties might be jeopardized. It seems certain, therefore, that public policy demands diversions of the summer flow even to the detriment of navigation, and that such conflicts will be adjusted to so allow.

"Monopoly" in Public Waters.

As ordinarily defined "monopoly" signifies that the "monopolist" has control over output and prices. So construed there can be no monopoly in the waters of our streams.

The various types of irrigation enterprises may be grouped as follows: United States Reclamation Service enterprises; Carey Act enterprises; irrigation districts; co-operative or mutual enterprises; commercial enterprises; and individual and partnership enterprises. As explained in the previous articles all of the types become mutual excepting the commercial enterprises—which supply water for compensation to parties who own no interest in the works. It has also been shown that the rates of the commercial enterprises are subject to regulation by public officers and that the water right of the enterprise belongs to the land owners and not to the operating company. It is therefore certain that so far as the water right is concerned no monopoly can exist in the irrigation business.

The expression is generally associated with the hydraulic development of electric power, but, as all public utilities are subject to rate fixing by the proper state authorities, any control of output and prices can be terminated. According to present decisions the water right of power plants is vested in the owner thereof, and this must always be the rule where the riparian right exists. In the case of appropriation rights legislation should be adopted providing that appropriations for power purposes may be authorized as indeterminate licenses and that the water right shall be considered of no value in rate fixing and in condemnation by the state or other public unit. There is no more reason why a power company should be allowed to capitalize a water right than there is for an irrigation company. In regard to other franchises the courts have been doing their part in attempting to reduce fictitious capitalization, and it is high time for all legislative bodies to positively provide for the elimination of any chance of capitalization in franchises granted by them or under their acts.

Legislation Regarding Appropriations.

Every Western state has statutes fixing the procedure to be followed in making appropriations. Arizona, California, Colorado, Kansas, Montana, Texas and Washington have departed little, if at all, from the method of posting notices. The remaining irrigation states have a central office, the state engineer's, in which applications for permission to appropriate water are filed and the conditions fixed under which the right may be perfected. Most states give this central office the right to reject an application for specified reasons—like lack of water supply, interference with prior rights, or detriment to the public welfare. Such statutes have been in force for over twenty years and there are practically no cases showing an abuse of the power of rejection.

A number of states have the central office publish the application so that all interested may be heard in regard thereto before final action thereon. This practice has proved of great benefit to both the old and the new appropriators. It gives present users an opportunity to know about and protest against any appropriation which might prove detrimental to their own, and it shows the intending appropriator the true situation before he expends any money in construction. Every state following the old method has instances of the construction of works whose operation was enjoined immediately after completion. The new method aims to eliminate such waste of time and money.

It must be emphasized that the new legislation controlling appropriations is based upon no new legal principles. It simply offers an improvement in the details of administration—just as a modern auditing system makes it possible for a business house to more easily control its operations. Under the new system the appropriator is under state control from the initiation to the completion of his project. It is a control, however, which protects, rather than prohibits, bona fide projects. In those states using the old method of posting notices the records are useless as evidences of work actually done, and one is never certain of the status of his right during construction.

In those states having no special legislation for the determination or adjudication of existing rights to the stream flow, the status of the various rights is settled only by ordinary court action. It is therefore possible to have dozens of law suits over water rights on a stream without all the water users being brought into any one of them. The new system provides a method for the determination of all rights in a single proceeding. Colorado, Idaho, Utah, North Dakota, South Dakota, Oklahoma and New Mexico provide for adjudications directly by the courts, and Wyoming, Nebraska and Nevada determine rights through a non-judicial officer or board. Oregon in 1909, combined the two by providing for a determination by a board which must be affirmed or modified by the circuit court before becoming final.

As the states in which rights are determined by a board have secured the best results, and, as the Oregon method meets the approval of those who think

such determination a strictly judicial matter, it is recommended that the Oregon method be followed in the states not included in the enumeration above. So far as bringing all claimants into one action is concerned many courts have held that they now have that power and have refused to consider the merits of a case until all claimants were made parties. The newer legislation, therefore, simply insures this being done in every case.

Although one may be successful in the ordinary lawsuits regarding water rights in those states in which the new legislation has not been adopted, he is without protection, other than further court action, if the wrongful diversions continue. Here again the abler courts have taken the matter into their own hands and have appointed officers to divide the waters in accordance with the decree and at the expense of the parties interested. The new legislation cares for the distribution by dividing the state into districts with water commissioners to apportion the waters therein in accordance with the determination of rights. The system was first introduced in Colorado in 1879 and has been accepted by all the western states with the exception of Arizona, California, Kansas, Montana. Texas and Washington.

The new legislation regarding water rights by appropriation effectively provides for the three essentials; first, the determination of existing rights; second, the distribution of water among those entitled to its use; and third, the control of the acquisition of new rights. It is working so well in the many states in which it has been adopted that there is no good reason why it should not be generally accepted. It is certain that a more general knowledge of its many good points would dispel the existing prejudice against any change in such matters and bring about the desideratum in legislation regarding our public waters.

OWL CAR SERVICE AT PORTLAND.

To ascertain whether or not own car service is actually needed in Portland, B. S. Josselyn, president of the Portland Railway, Light & Power Company, has just notified Mayor Rushlight that his operating department has arranged a service over the principal trunk lines of the city each half-hour during the night for a period of 30 days. These cars have been put into service on 17 of the 26 lines in the city. Officials of the company will keep careful check on the service and make a report at the end of 30 days as to the success or failure of the new undertaking.

SAN FRANCISCO TRANSPORTATION PROBLEM.

Preliminary Report No. 7—Part 1. Improvements in Rolling Stock.

BY BION J. ARNOLD.

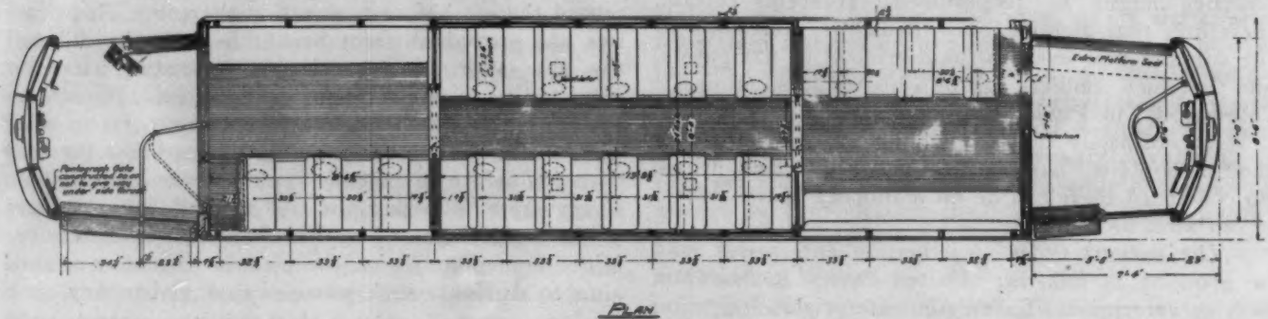
Ultimately, I shall make recommendations regarding the design of all car equipment and for a future standard car as well as for improvements in certain types of present equipment calculated to better serve the needs of the passenger traffic in San Francisco. In the present report, I shall confine myself to the so-called 1912 car, which should be considered from two standpoints:

First, whether it approximates the proper standard for future equipment, and if not,

Second, whether it is suited for operation on certain lines, in its present form.

Synopsis: The various items in the make-up of a complete car to be subjected to analysis (from the standpoint of the public) are as follows:

(1) Seating arrangement.
(2) Facilities for quick loading and unloading.
(3) Storage space—platform and car floor.



PLAN

Car for Geary Street Municipal Railway.

(4) Car proportions, with reference to street clearance.
(5) Height and type of steps.
(6) Ventilation and lighting.
(7) Designating signs.

The proportions of the 1912 car are practically the same as the later equipment now in service on Sutter street, and, excepting width, also approximate the proportions of the Geary street cars, that is, as regards truck centers, wheel base, length of body and platform, and height. The arch roof used (sometimes called the turtle-back roof), however, is new to the United Railroads practice, except in the case of a few remodeled cars which have been built in the company's shops and have been placed in service within the present year. And except in the case of these few cars, the 1912 design embodies for the first time in a San Francisco prepayment car the "California" type arrangement of car body with closed and open sections.

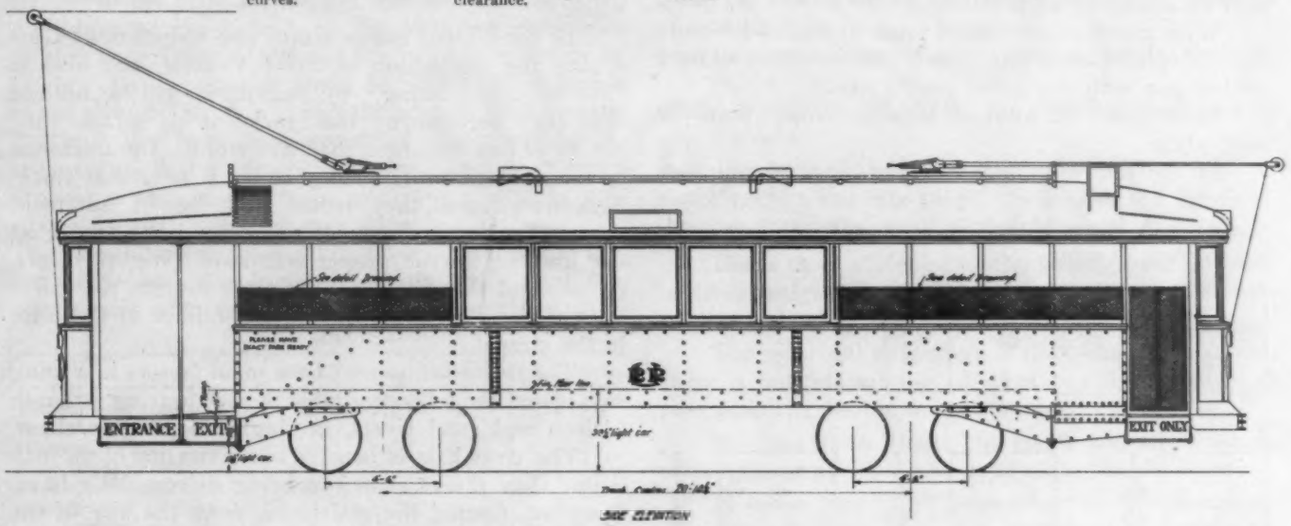
Inasmuch as this new equipment may possibly operate on the Sutter Street lines in competition with Geary Street, the following comparison will be of interest. Only such features as differ materially from the Geary Street cars or require further modifications are compared herein for discussion.

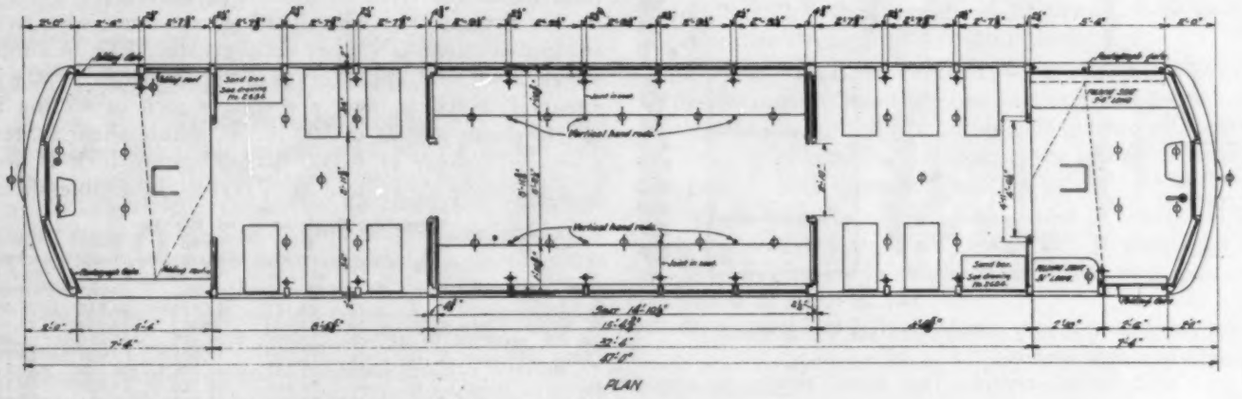
Considering these two designs together from the standpoint of the most suitable car for the City of San Francisco, I believe the Geary Street is superior, although even it may require some minor modifications as a result of experience with the initial order. The two differ materially in the matter of seating arrangement and width of car.

Comparison of Designs.

	Geary Street.	United Railroads.
1. Proportion of cross seats to total fixed seats.	73 per cent.	45 per cent.
2. Longitudinal seats.	Half of end compartments on entrance side.	Entire closed compartment.

	Geary Street.	United Railroads.
3. Average spacing of cross seats.	30½ in. to 31 7-32 in.	29 in.
4. Principal standing space.	End compartments, opposite entrance way.	Middle or closed compartment.
5. Seat proportions.	17 in x 34 in.	16 in. x 32 in.
6. Width of aisles.	24 in minimum, 28 in. at shoulder line.	About 36 in. minimum between seat hardware, 40 in. at shoulder line.
7. Width required for seat over-all.	37 1-8 in.	35 in. or more, depending upon the type used.
8. Width of car body.	8 ft. 6 in.	9 ft. 2 in.
9. Platform.	Side sills tapered to provide clearance at curves.	Sides kept straight because fenders limit clearance.





† Buffers.
‡ Lights.

1912 Type of Car Proposed by United Railroads.

10. Minimum rear entrance width.	40 in.	32 in., due to contraction of hand-railing, locaton of and difference in types of controller.
11. Bulkhead width.	Open between corner posts 69 in.	False partitions, open in 53 in.
12. Position of exit door.	Next to car-body bulkhead.	Next to car bumper, with seat intervening.
13. Minimum exit width.	29 in.	27 in.
14. Guide rail.	Uses Oakland radius bar for obtaining full step entrance. Motorman protected by movable guide rail.	Guide rail cut off at stanchion to permit full-width entrance.
15. Type of step.	Folding type, raised on blind side of car.	Fixed steps.
16. Platform fixtures.	Master type controller to reduce space occupied.	Type K control opposite narrowest entrance-way
17. Window sash.	Raise sash in closed sections.	Sash fixed.
18. Storm protection, open section.	Drop curtain.	None.
19. Ventilators.	Automatic eductors in roof, and floor intakes.	Intake and exhaust funnels.
20. Sanders.	Positive air blast sanders delivering close to wheel.	Gravity sanders.

Summary of Recommendations.

The improvements which I am able to recommend depend to a large degree upon the service intended, as suggested in the introduction; i.e., whether this new equipment is intended for general use in all parts of the city, i.e., interchangeable as regards routes, or for operation on certain lines only. In either case, I should like to see the following improvements included:

(1) Taper platform, to provide for future clearance operation.

(2) Front exit gate next to the bulkhead.

(3) Straightened guide rail to provide greater entrance width, or

(3a) Conductor's stand in center of bulkhead opening and elimination of present form of guide railing.

(4) Motorman protected by movable guide rail.

(5) Geary street or equivalent seating arrangement.

(6) Cross-seat cushions 17 in. x 34 in., spacing 30 in. or more. All cushions spring backed.

(7) Raised sash in middle or closed section.

(8) Bulkhead open between corner posts.

(9) Folding steps instead of fixed steps.

(10) Storm curtains or equivalent protection.

(11) Ventilating intakes in floor or sides of the car.

(12) Positive air blast sanders.

(13) More liberal spacing per passenger for longitudinal seats where vertical stanchions are used in place of straps.

[To be continued.]

THE FACTOR OF SAFETY.

As Called for by the United States Tables of Steam Pressure on Steam Boilers.

REVISED BY J. B. WARNER.

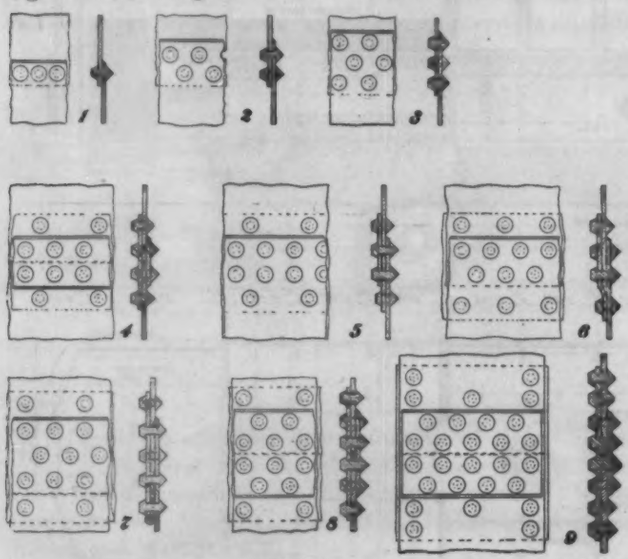
Proportions of Riveted Joints.

With the high steam pressures carried on many boilers at the present time, one of the most important factors entering into construction of steam generating apparatus is that the joints or seams shall have as high an efficiency as possible.

With a well-proportioned joint, as high a pressure may be carried with safety on a thinner sheet as on a thicker one with the joints poorly made.

In all cases the joint or seam is weaker than the solid plate.

In the following cut we give nine examples of joints in common use. There are many other kinds of seams giving a higher or lower efficiency, according to their design.



Joints.

Joint No. 1, is a single-riveted lap joint, with the rivets in single shear.

No. 2, double-riveted lap joint, rivets in single shear.

No. 3, triple-riveted lap joint, rivets in single shear.

No. 4, a double-welt butt joint, with two rivets in double shear, and one in single shear.

No. 5, single-welt lap joint, all the rivets in single shear.

No. 6, single-welt lap joint, all the rivets in single shear.

No. 7, single-welt lap joint, all the rivets in single shear.

No. 8, double-welt butt joint, with four rivets in double shear, and one in single shear.

No. 9, Double-welt butt joint, with eight rivets in double shear, and three in single shear.

When the above joints are properly proportioned the efficiency, percentage, or proportion of strength to the strength of the solid plate, should be as follows:

Joint No. 1....	51.4 per cent	to 58.6	per cent
Joint No. 2....	67.3 per cent	to 73.9	per cent
Joint No. 3....	72 per cent	to 75	per cent
Joint No. 4....	80 per cent	to 81	per cent
Joint No. 5....	80 per cent	to 82	per cent
Joint No. 6....	77 per cetn	to 79	per cent
Joint No. 7....	85 per cent	to 87	per cent
Joint No. 8....	86 per cent	to 87.5	per cent
Joint No. 9....	93 per cent	to 94	per cent

Where a single strap is used it should be of the same thickness, and of as good quality as the shell plate. Where double-butt straps are used they should each be at least three-fourths the thickness of the plate.

In the United States Rules and Regulations Governing the Inspection of Steel Vessels, and also in "Marine Engineering," by Seaton, it will be noticed that they recommend that each of the straps shall not be of less thickness than five-eighths the thickness of the shell plate. In many cases, if only that thickness were used, they would not be of sufficient strength, after drilling for the rivet holes, to bring the joint up to the proper standard. We, therefore, recommend that they each be three-fourths the thickness of the shell plate, to prevent failure of the joint in the straps.

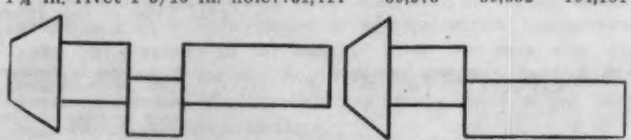
The rivets being one of the main factors in a joint, we append the following table of the shearing strength of iron and steel rivets, in single and double shear.

The rivet hole is usually one-sixteenth of an inch larger than the rivet before being driven. We have, therefore, figured the resistance, from the size of the hole which the rivet should fill when driven.

It is found that the shearing resistance of a rivet in double shear is 75 per cent. greater than in single shear, also, that the average of good iron rivets will shear at 38,000 pounds per square inch of section in single shear, and at 66,500 lb. in double shear. Steel rivets will shear at 44,000 lb. per square inch of section in single shear, and at 77,000 lb. in double shear.

Shearing Resistance of Rivets.

Size of rivet and hole.	Iron rivet, single shear.	Iron rivet, double shear.	Steel rivet, single shear	Steel rivet, double shear.
⅝ in. rivet, 11/16 in. hole...	14,105	24,683	16,332	28,581
11/16 in. rivet ¾ in. hole...	16,784	29,372	19,434	34,008
¾ in. rivet 13/16 in. hole..	19,703	34,478	22,814	39,923
13/16 in. rivet ⅞ in. hole...	22,849	42,091	26,457	46,300
⅞ in. rivet 15/16 in. hole...	26,227	45,895	30,368	53,144
15/16 in. rivet 1.0 in. hole...	29,845	52,228	34,557	60,474
1.0 in. rivet 1 1/16 in. hole...	33,668	58,919	38,984	68,222
1⅛ in. rivet 1 3/16 in. hole..	42,066	73,614	48,708	85,239
1¼ in. rivet 1 5/16 in. hole..	51,414	89,973	59,532	104,181



Double Shear. Single Shear.

In laying out boiler plate for riveted joints the size of the holes should be in proportion to the thickness and tensile strength of the plate, and the rivets spaced close enough to insure a tight joint when the work is complete.

Having decided upon the size of the rivet hole, the pitch of the rivets can readily be found.

Example: Suppose we have a plate ⅜-in. in thickness, 60,000 lb. tensile strength, and we wish to make a double-riveted joint with 13/16-in. iron rivets, driven in ⅞-in. rivet holes, we multiply the thickness of the plate by the tensile strength, and obtain the breaking strength of a strip of the plate 1 in. in width, thus $.375 \times 60{,}000 = 22{,}500$ lb. This result, divided

by 16, will give us the strength of a strip of the plate 1/16-in. in width.

By the foregoing table we find that one 13/16-in. rivet, driven in a 7/8-in. hole, will shear at 22,849 lb. (if in single shear), and two will shear at 22,849 × 2 =45,698 lb. If the shearing resistance of the two rivets is 45,698 lb., and we have found the breaking strength of a strip of the sheet 1/16-in. in width to be 22,500 ÷ 16 = 1406 lb., it will require as many sixteenths of the plate for the net section (plate between the edges of the holes), as the shearing resistance of the two rivets 42,091 ÷ 1406, which is 30/16, or 1 7/8-in. To this result must be added the diameter of the rivet hole (7/8-in.), and the centers then become 2 7/8 in. We have now equalized the shearing resistance of the two rivets, and the breaking strength of the net section, and made as strong a joint as possible with that size rivet and plate.

The following table gives a very good proportion for single and double-riveted joints with good efficiency, and when properly made, tight work.

LAP JOINTS.

	Inches.	Inches.	Inches.	Inches.	Inches.
Thickness of plate	1/4	5/16	3/8	7/16	1/2
Diameter of rivets	11/16	3/4	13/16	15/16	1.0
Diameter of rivet hole	3/4	13/16	7/8	1 0	1 1/16
Pitch single riveting	1 13/16	1 7/8	1 7/8	2 1/16	2 1/16
Pitch double riveting	2 7/8	2 7/8	2 7/8	3 1/4	3 1/4
Strength of S. R. joint, per cent	58 6	56 0	53 3	51.5	51.4
Strength of D. R. joint, per cent	73 6	71 1	69 56	69 2	67.3
Distance between rows	1 5/16	1 5/16	1 5/16	2 3/16	2 3/16

Table of proportions of boiler plate, having a tensile strength of from 50,000 to 60,000 lb., riveted with iron rivets in single shear.

Triple-Riveted Joints.

A lap-joint triple-riveted may have a higher efficiency than one double-riveted, as we have one more rivet to shear, the pitch can be increased, therefore giving more strength to the net section. In that style of joint the rivets will be in single shear, as shown in cut No. 3.

Example—Triple-riveted joint, steel plate, tensile strength per sq. in. of section = 60.000.

Thickness of plate 3/8-in. = decimal 0.375.

Area of 13/16 rivet hole = decimal 0.5185.

Pitch of rivets 3 1/4 in. = decimal 3.25.

Shearing resistance of iron rivets per sq. in. of section = 38,000 lb.

Then 3.25 × 0.375 × 60,000 = 731,125 lb. strength of solid plate.

(3.25 — 0.8125) × 0.375 × 60,000 = 54,843 lb. strength of the net section.

0.5185 × 3 × 38,000 = 59,109 lb. strength of the three rivets in single shear.

The net section of the plate is the weakest, therefore; 54,843 ÷ 73,125 = 75 per cent, efficiency of joint.

Double Welt Butt-Joint.

Joint No. 4, having four rows of rivets, the inside or center rows being in double shear, while the outside row (on each side), which is in double pitch, is in single shear.

A joint so designed will give two rivets in double shear and one in single shear, as the center row takes the sheet and both straps, while the outside row takes the sheet and inside strap only.

Example—Suppose the sheets to be 3/8-in. in thickness, 55,000 lb. tensile strength.

Rivet holes = 13/16-in., the center rows being pitched 2 3/16-in. (center to center of rivets), and the outside rows being pitched 4 3/8-in., the problem would be as follows:

4.375 × 0.375 × 55,000 = 90,234 lb. strength of the solid plate.

(4.375 — 0.8125) × 0.375 × 55,000 = 73,476 lb. strength of net section.

Area of rivet hole = 0.5185.

Shearing resistance of two rivets in double shear = 68,956.

Shearing resistance of one rivet in single shear = 19,703.

68,956 + 19,703 = 88,659 lb., the shearing resistance of 3 rivets.

The net section is the weakest, therefore; 73,476 ÷ 90,234 = 81.4 per cent as the efficiency of the joint.

Single Welt Lap-Joints.

These three styles of joints, largely used on locomotives designed to carry high pressures, or on boilers having jackets or covering hard to remove.

The principal advantage is that, being a lap-joint, there is but one calking edge to keep tight instead of two, as in the double welt butt-joint.

In these three joints the rivets are all in single shear; the strap should be as thick as the shell-plate.

In joints Nos. 5 and 7 the center rows of rivets are in single pitch, while the two outside rows are in double pitch. This should give an efficiency of 80 to 82 per cent, the strength of the solid plate.

In joint No. 6 the center rows are in single pitch, while the outside rows are one and one-half pitch; all four rivets in single shear. This will give an efficiency of 77 to 79 per cent the strength of the solid plate when the joint is well proportioned.

These joints are figured the same as joint No. 3, except we have more rivets to shear. In joint No. 5 we have five rivets in single shear. This will give an efficiency of 80 to 82 per cent.

In joint No. 7 we have seven rivets in single shear, with an efficiency of 85 to 87 per cent when properly proportioned.

Joint No. 8 is the usual type of double welt butt-strap joint used on large boilers, with heavy plate, especially for marine boilers.

In No. 8 the four center rows of rivets are in double shear; the two outside rows are in single shear.

In this type of joint we have four rivets in double shear and one in single shear. The center rows are in single pitch, while the outside rows are in double pitch. This should give an efficiency of 85 to 87.5 per cent the strength of the solid plate.

Joint No. 9 is of the same type, except that the inside strap is made wider, so that it will not only take a row of rivets in double pitch, but will also take an outside row in four pitch.

The effect of this is, as above explained, in reference to the triple-riveted joint. It increases the strength of the net section of the plate, so that when the straps are of sufficient thickness to make up for the loss drilled out of the shell-plates for rivet holes, it increases the efficiency of the joint to 93 or 94 per cent the strength of the solid plate.

[To be continued.]

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POWER AND GAS

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Prison Labor and Good Roads

The State of Montana for many years found it necessary to expend more money to maintain its criminals in enforced idleness than its legislators appropriated in sum total for the dispensing of a liberal education at the State University. This enforced idleness brought on largely by union labor agitators resulted in many instances in young men convicted of offenses not involving moral turpitude being compelled to associate with hardened and experienced offenders as cellmates.

A new condition of affairs is now, however, to be found in that great commonwealth. In our last issue we published details of costs in road building now actually being accomplished with prison labor in the construction of county highways. The new system by its life-inspiring hope to the prisoner is not only bringing about an enormous saving to the state but is best of all raising again to citizenship a lost band of men hitherto hopelessly drifting along without the slightest encouragement for them to ever again raise the head of self respect.

Albert J. Galen, attorney general of Montana, reports that without difficulty and with but comparatively few escapes, or attempted escapes, a crew of seventy-five prisoners can be successfully managed with three guards, who act more in the capacity of overseers of the work, than as guards. They are housed in tents at night, and their meals are served in a large mess tent. None of the guards are armed, and there is a very noticeable absence of cages, shackles, ball and chain, handcuffs and other such instruments of restraint. Of course the prisoners so trusted are furnished with clothing which does not brand them as prisoners, and this tends to preserve their self-respect; they are dressed in cadet blue suits, are furnished with better food and confidence is reposed in them as men. The results obtained by this honor system tends to give more confidence in human nature, and it is seldom that a prisoner disregards the confidence reposed in him. Instead of being despondent, morose and vindictive, the prisoner lives in hope, and on discharge is better fitted mentally and physically to again re-enter the struggle of life and work and live in accordance with the laws of society. Many states have attempted the employment of prisoners, but without the same satisfactory results. In some states, where prison labor is utilized for public road construction, the prisoners are forced to work under armed guards, held in restraint by manacles, and housed at night in portable cages, resembling very much such a wagon as is used in a circus for exhibiting ferocious animals. This system is necessarily expensive; and it is not surprising that the prisoners do not give the same satisfaction as under the Montana method.

The slogan of the day is "good roads for 1915." Every county and every state in the West fairly vibrates with agitation looking toward improvement in public thoroughfares. The Pacific Highway, conceived in audacious fancy so recently, is even now daily becoming a concrete reality. The experience in Montana is proving so economic and yet so life-giving and uplifting to that pitiful class known as

"fallen man," that our public leaders may well consider adopting this excellent system to all other sections of the West.

Western Water Rights and Legislation

In this issue of the Journal is concluded the widely discussed series of articles on Western water rights by A. E. Chandler, the well-known water right expert. Those of our readers who have closely followed the various discussions have been deeply impressed with one predominating feature; namely, a lack of uniformity of action in Western states in water right legislation. The statutes largely governing in water right decisions are based in the main upon the socalled "common law," and as the common law must be adapted to time and place, it is not to be wondered that different Western localities, varying in necessity for water supply, have developed widely differing procedure. Yet it is deplorable that uniformity and consistency does not exist. Some one has long since, in the anguish of his soul, said "Oh consistency, thou art a jewel," and truly would it be could Western water rights proudly boast this trait.

It has been clearly shown that hope for the future lies more in the liberality of the courts than by legislation. No longer is the doctrine of riparian rights tolerated in the thirsty West save in those states alone that may be classified as semi-arid in character. Even in these, however, it is glaringly apparent that the ultimate highest development demands utmost liberality in decision—a liberality in decision that would lead the courts of California, for instance, to disregard the time dishonored riparian doctrine and adhere to it only in such cases as would bring about manifest injustice should it be departed from. This liberality in decision should lead the courts to base their conclusion on what would constitute reasonable use and elimination of waste in the apportionment of the waters of a commonwealth and not leave the rights to this absolute Western necessity tied up to a piece of land simply because the decline of geologic ages happened to expose a path for erosion across a particular tract of land.

Indeed, highest use and greatest development, the lessening of the statutory period for laying claims to riparian rights, and a zealous display of public policy looking toward encouraging "first aid" to arid lands of the West would help wonderfully in the present entanglement. Oregon, Idaho and Wyoming seem at present to lead in highest development of water right legislation and evolution. In these states the practical control by a state officer—known as the state engineer, has evolved an efficient and ready means of water jurisdiction. The years of litigation incident to a successful and final determination of Western water rights have done much to discourage development in many localities of the West.

The Oregon law possesses three remarkable features that may well be emulated by other Western states. First, the data on existing rights is easily and impartially gathered by the state engineer. The gathering, of such data by the several biased parties to the issue is often the cause of more disputes and unjust delays and expense than any other feature of water right adjudication. Again, an equitable and firm hand is legally authorized to impartially distribute the adjudicated rights. Thus is secured in an efficient manner the consummation of the findings of the water commission and the decision of the court. And finally, an immense stride forward is taken by definitely maintaining the control of the acquisition of new water rights in the future.

In Colorado, when it is desired to appropriate water, publicity is given so that older owners of rights on the stream may have service and thereby be given ample time for just complaint. The new appropriator is consequently duly warned of troubles ahead before money is sunk in construction. Wise legislation, such as this, in other Western states would on many occasions have avoided years of costly litigation, and the wasting of much needed capital in growing communities of the West.

Another phase of the water right situation is comparable to the utility franchise. The past decade has seen endless strife in the wrangles of city councils and the street railway officials as to the capitalization of franchises. The issue seems now almost clean cut. Since the smoke of battle has cleared away, almost universally is it recognized that a franchise is a public trust and as such it becomes not the property of the utility company. Indeed, the latter day ideas of the franchise are so far divorced from ownership that the utility franchise is generally recognized as being the signet ring to pledge to the city that the utility company will "love, serve and obey" the mandates of the giver. On the other hand, the evolution of the indeterminate franchise brings new responsibilities upon the people and the municipality at large, which calls for a paternal protection and guarantee of fair play never before aroused in the public conscience.

So it will eventually be with the holder of hydroelectric water rights. The courts have ruled that the irrigation company supplying water to irrigable lands but not owning the land itself, has no ownership in the water rights but that these rights pertain to the land so supplied. The question of fixing a value to a hydroelectric water right is indeed perplexing and intricate. Many argue—and with convincing reasons—that no value should be attached to a power water right in determining rates for hydroelectric energy. It is urged that all such rights should be authorized as indeterminate licenses and thus control forever the direction of this gigantic unceasing natural resource.

There are many things to be considered in putting forth such assertions. To arrive at an equitable solution to the people at large an injustice almost bordering on confiscation will have to be done. In the ultimate solution, however, no one should lose sight of the fact that at least a liberal allowance should be made somewhere in the capitalized account, whether called value of water rights or not, for the brains, the originality, the audacity and the far-sighted constructive statesmanship of those who have developed in the West the world-beating triumphs of the hydroelectric industry.

PERSONALS.

E. E. Baker, secretary of the Mt. Whitney Power Company, of Visalia, is at San Francisco.

J. W. White, chief engineer of the Vix Engineering Company, is at Los Angeles on business.

Goodwin Trent, an engineer of Los Angeles, is a recent arrival at San Francisco from the South.

R. M. Alvord of the San Francisco office of the General Electric Company, expects to leave this week for a month's trip East.

S. L. Stovall, electrical and hydraulic engineer with the Mt. Whitney Power Company at Visalia, Cal., was at San Francisco this week.

Charles C. Hillis, general manager of the Electric Appliance Company, returned to San Francisco during the week after a business trip to the East.

Erwin Schwartzkopff, an electrical engineer of Berlin, has been visiting San Francisco and looking over the electric power plants in this vicinity during the past week.

Harry A. Storrs has recently associated himself with Edmund T. Perkins Engineering Company, First National Bank Building, Chicago, as consulting electrical engineer.

John B. Miller, president of the Southern California Edison Company of Los Angeles, recently arrived at San Francisco from his home at Pasadena, accompanied by his wife and daughter.

B. C. Carroll, general agent of the Pacific Telephone & Telegraph Company, accompanied the "Flying Legion" to Victoria, B. C., during the past week to "boost" for the Exposition of 1915.

W. B. Cline, president of the Los Angeles Gas & Electric Corporation, came up from the South, with Mrs. Cline and two daughters, who embarked at San Francisco for a trip to Manila on the steamer Manchuria.

R. J. Dinwoody has severed his connection with the Capital Electric Company of Salt Lake City, to join the sales department of the Inter-Mountain Electric Company, wholesale electrical jobbers in that city.

S. M. Sammis, chief engineer of the Marconi Wireless Telegraph Company recently returned to San Francisco after visiting the Hawaiian Islands in connection with negotiations for a site for a wireless plant at Honolulu.

A. W. Leonard, manager of the Minneapolis General Electric Company, has been prominently mentioned during the last few days as the possible successor of Richard T. Laffin, late vice-president of the Puget Sound Traction, Light & Power Company of Seattle.

E. G. Williams, J. G. White & Co.'s general manager of construction, is expected to arrive at San Francisco from New York during the coming week to look over the grading work that is being started on the Oakland, Antioch & Eastern Railway, which will be extended to Sacramento within six months.

Frederick S. Myrtle, the head of the Pacific Gas & Electric Company's publicity department, is visiting Victoria with the "Flying Legion" of San Francisco business men who left August 22d for British Columbia on a "boosting" excursion for the purpose of exciting interest in the Panama-Pacific International Exposition.

Wynn Meredith, of the firm of Sanderson & Porter, the consulting engineers for the General Pipe Line Company, during the past week accompanied Engineer **David Dorwood** on an inspection trip covering the work in progress on the 80-mile steel pipe line, which is to connect the wells of the Esperanza group with tidewater at San Pedro.

W. J. Lloyd of Chicago has been appointed general superintendent of the Mountain Division of the Western Union Telegraph Company, with headquarters at Denver. The territory under his jurisdiction includes Utah, New Mexico, Idaho, Montana, Wyoming, Colorado, Kansas and Nebraska. He entered the service of the company as a messenger at Dubuque, Ia.

OBITUARY.

Ralph Carter Peck, Pacific Coast lamp specialist for the General Electric Company, died at the home of his parents at Berkeley, August 25, after a lingering illness. He was a native of San Francisco and was 32 years of age and unmarried. He is survived by his parents, Mr. and Mrs. Edwin T. Peck, and a sister, Elizabeth T. Peck. The funeral services were held at the residence, August 27. Berkeley Lodge No. 1002, B. P. O. E., of which Mr. Peck was a member, was represented. As he was for a number of years connected with the General Electric Company the pall bearers were selected from his old associates in the service, including T. E. Bibbins, E. O. Shreve, F. D. Fagan, E. A. Hunt, W. V. Doughty and C. A. Loring.

Mr. Peck showed great ability during his long connection with the General Electric Company, with headquarters at the San Francisco office. He worked up from a clerical position in the order handling division to that of incandescent lamp specialist for the Pacific Coast, which he assumed in 1909. He has been greatly missed by his associates since illness compelled him to leave the office last April.

ELECTRICAL JOBBERS AT TAHOE.

As detailed in these columns last week the electrical supply jobbers of the Pacific Coast and their guests enjoyed a week-end outing at Lake Tahoe. Aside from the boating and fishing interest centered in the pool and bowling contests, H. E. Sanderson being the winner in the latter. The banquet on Saturday evening was attended by about thirty. J. A. Vandergrift acted as toastmaster. Albert H. Elliott spoke on the "Spirit of Lake Tahoe," H. V. Carter also responded in his customary able manner. W. L. Goodwin spoke on behalf of the jobbers, and T. E. Bibbins for the manufacturers.

ELECTRICAL LEAGUE OF SOUTHERN CALIFORNIA.

The Electrical League of Southern California was organized in January of this year as an outgrowth of the Electrical Lunch Club. The league now has an active membership of 121 and has accomplished much good in bringing harmony and co-operation into the electrical business. Among other new plans which are to be instituted when it reconvenes on September 3 is the establishment of a "suggestion box" from all members as to what the league can or should accomplish. A smoker and entertainment is to be given to the members on August 31.

JOVIAN CLUB OF SAN FRANCISCO.

An enthusiastic meeting of the Jovian Lunch Club of San Francisco was held at Tait's Cafe, August 27. The principal business was the adoption of the report of the temporary governing board of which R. M. Alvord had been made chairman, W. I. Otis, vice-chairman, and W. W. Hanscom, secretary and treasurer. On the committee on nominations to be presented at the annual meeting on September 3, Chairman Alvord named H. V. Carter, chairman; C. F. Butte, W. R. Dunbar, J. E. Vandegrift and M. E. Wise. The membership committee for the Rejuvenation on September 10, consists of A. H. Halloran, chairman; Louis Levy, W. L. Goodwin, W. W. Briggs, G. E. Holberton and A. W. Bullard. The next meeting will be held at 12:15, September 3, at Tait's cafe.

ENGINEERS' CLUB MEETING.

The engineers' club of San Francisco was interestingly addressed last Tuesday noon at the Palace Hotel by Director Smith of the Philippine Bureau of Mines. Mr. Smith particularly pointed out many of the engineering difficulties met with in the Philippine Islands and not encountered in this country.

ARNOLD TO REPORT ON SACRAMENTO RAILWAYS.

Bion J. Arnold, the eminent traffic expert, has been engaged by the Pacific Gas & Electric Company to make a complete investigation of their electric street railway system at Sacramento, California. His report will include every detail of construction, operation and maintenance except the valuation, which has already been made by J. G. White & Co.

TRADE NOTES.

The Stewart-Fuller Company has been awarded the conduit contract for the new Geary Street Municipal road at San Francisco.

The Southern Pacific Company, West Oakland, Cal., has ordered from the Westinghouse Electric & Manufacturing Company one 300 kva., 3 phase, 4000 volt, 62½ cycle synchronous condenser.

The Caldwell Traction Company, Caldwell, Idaho, has recently ordered from the Westinghouse Electric & Manufacturing Company one quadruple equipment of No. 306 motors with K-35-G control.

The Westinghouse Electric & Manufacturing Company has recently received an order from the Ewbank Power Transmission & Motor Company of Portland, Ore., for one quadruple equipment of No. 304-A railway motors.

The Westinghouse Electric & Manufacturing Company has received an order from the Pacific Electric Railway Company, Los Angeles, Cal., for thirteen type No. 267-E line switch equipments for use as contactors with quadruple 125 h.p. motors and L-4 controllers.

The Triumph Electric Company of Cincinnati announces through its San Francisco agent, Mr. G. A. Wilbur, the sale of two 75 kw., d.c., engine type, 3 wire generators, to the California Hydraulic Engineering & Supply Company. These generators are to be installed in the Spalding Building at Portland.

Sacramento has finally abolished the flat rate for electric current, being the first town of any size in California south of the lines of the Northern California Power Company to adopt meters. The General Electric Company has received an order from the Pacific Gas & Electric Company for about 9000 meters, which will be rapidly installed. Many of the houses are also being rewired.

John S. Baker, Pacific Coast district manager for the Crocker-Wheeler Company, announces the sale of a quantity of electric apparatus to the Southern Sierras Power Company for installation at Plant No. 3. The specifications call for the following: Three 2250 kva., 300 r.p.m., 60 cycle, 3 phase, 2200 v., water wheel driven generators. Also one motor-generator exciter set, one 100 kw. water wheel driven exciter set, and complete switchboard controlling main generators and exciters. The generators will be direct-connected to three water wheels designed by George J. Henry Jr., and will have solid poles, which particularly adapts them for operation in parallel over long distances such as will be necessary in operating to San Bernardino.

NEW CATALOGUES.

There has just been issued by the General Electric Company an attractively bound book of 132 pages, Bulletin No. 4958, devoted to the use of the "higher voltages" in the operation of Direct Current Electric Railways. It contains numerous tables comparing the various costs of 1200 volt systems as compared with those of 600 volts. Bulletin No. 4978 illustrates various installations of electrically driven pumps used for irrigating purposes and contains charts giving comparative crop yields of irrigated and unirrigated lands. Bulletin No. 4932 is devoted to the application of Electricity in the Brewing Industry. Bulletin No. 4976 is devoted to Electric Drive in grain elevators and flour mills, and supersedes the company's bulletin on this subject.

NEWS OF CALIFORNIA STATE ELECTRICAL ASSOCIATION.

The Butte Electric & Engineering Company have been awarded the wiring for St. Ignatius church for the sum of $8300.

Some months ago a committee from the Electrical Contractors' Association, called on the board of works and attempted to show them that it was to the advantage of the city to finish the city hospitals by contract instead of by day labor, as it was being done by the former administration. The city architect at that time advised against same. But the architectural commission have advised differently and the result is that the hospital is being finished by contract. One large contract has been let to the Butte Electric & Engineering Company for the signal system, and on September 11 bids will be received for the balance of the work.

The contractors at their Saturday meetings are holding a series of talks on methods of handling material for jobs. Each speaker shows the blanks that he uses in his own business.

Russ Wolden, of the California Electric & Construction Company, gave the first talk on August 17th. C. F. Butte followed him on August 2. As each member is anxious to improve his methods a great deal of good is expected from this interchange of ideas.

It is the intention of the contractors to thoroughly discuss every system that is brought to their attention, thus allowing the members to get the best from each. As soon as this subject is gone over a new subject will be taken up.

A committee will take the good points from all systems and recommend same to the next State convention for a standard.

The contractors have changed their regular daily lunch place from Campi's to room 12 at Jules', at 12:15 sharp. Visiting contractors are always welcome.

Regular weekly meeting at Jules' at 12:30 sharp, every Saturday. Meetings adjourn at 2 p.m., sharp, as we have some baseball fans who never miss a Saturday game.

Among the large wiring contracts being figured are: Shreve's warehouse and factory, at Bryant and Thirteenth streets. Two hotel buildings, on Mission and Fourth streets. St. Francis church, Vallejo and Columbus avenue. Clift Hotel, Geary and Taylor streets. Apartment house, Larkin and Turk streets. Annex to Argonaut Hotel, Fourth and Jessie streets. Hotel building, north side of Mission street, between Fifth and Sixth streets. A fine residence for James Flood, Vallejo and Webster streets. It is reported that plans for the Regents Hotel on Sutter street have been abandoned and that Architect Polk has been ordered to get out plans for an office building. The above building is a very good illustration of the expense that a contractor can be put to, with no chance of receiving a penny for his labor, in order that an owner can make up his mind how he can best invest his money.

There has been spent by the electrical contractors on this one building alone, in its three previous trips on the market, about $2500. An amount equal to about 20 per cent of the amount of the lowest bid. When you multiply this amount by 10, being the number of different trades that have been asked to make up these estimates it can easily be seen where a great deal of money is wasted in unnecessary figuring.

It appears to the writer that the Board of Regents of our State University should be able to put up a building without all this unnecessary waste of other people's money. It looks as if a Board of Control is needed on the other side.

If any one that ordered photographs at the Contractors' convention and did not receive same, will notify W. S. Hanbridge at 1408 Merchants' National Bank Bldg., same will be investigated.

INDUSTRIAL

FREQUENCY METERS.

Frequency meters are extremely useful switchboard appliances, as they indicate immediately any variation in the speed of prime movers. By their use, irregularities in the operation of engine or waterwheel governors may be readily detected and immediately brought to the attention of the operator so that adjustments can be made. On circuits that

Fig. 1. Nine-Inch Frequency Meter.

supply induction motors driving textile mill and other machinery requiring constant speed, constant frequency is essential, and the installation of a frequency meter will constantly indicate the speed being maintained. In the central station supplying power and lighting service, the maintenance of normal frequency is equally important. Many watthour meters now on the market are adjusted for a particular frequency and register slow if the frequency is either below or above normal. A meter that will indicate a variation from normal frequency, therefore, tends to prevent this loss of revenue.

The Westinghouse frequency meters, two new types of which are here illustrated, indicate the frequency accurately by means of a continuous scale and pointer.

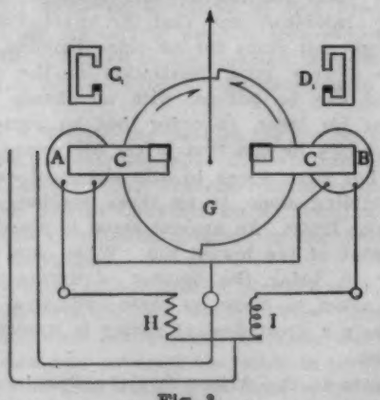

Fig. 3.

The meter consists of two induction voltmeter elements, A and B, Fig. 3, acting on a disk, G, and tending to move the disk (and the pointer shaft) in opposite directions. One of the elements is in series with a resistor H and the other in series with a reactor I, so that any change in the frequency tends to change the relative strength of the two magnets and cause rotation. The disk is so shaped that, as it moves, the amount of its metal under the strongest magnet becomes less than that under the weaker magnet, so that with every relation between the two magnet strengths there is some point where the torques produced by the two magnets balance and the pointer comes to rest. Magnet A tends to turn the disk in clockwise direction, and magnet B in the opposite direction.

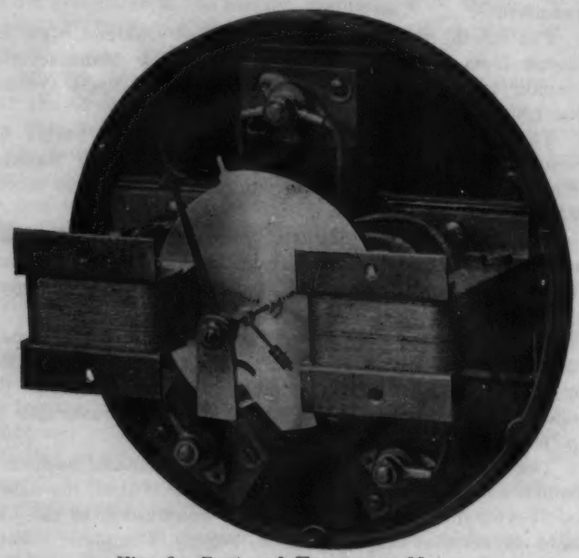

Fig. 2. Parts of Frequency Meter.

The torque of each magnet is proportional to the square of the current in the coil and to the frequency. At normal frequency, the torques balance when the disk is in the middle position. If the frequency increases, the current in coil A, which is in series with resistance only, remains unchanged and its torque increases because of the higher frequency; the current in coil B, which is in series with reactance, diminishes and its torque diminishes correspondingly. The disk, therefore, turns toward the right. For similar reasons, if the frequency decreases, the disk turns toward the left.

If the periphery of the disk were a true circle, any change in frequency which would cause the torques of the two magnets to be unequal would produce continuous rotation in one or the other direction. The disk is, therefore, made of a special shape. The left-hand edge of the disk, which moves under magnet A, is practically the arc of a circle, having its center at the shaft. The right-hand edge, which moves under magnet B, is practically the arc of a circle with its center slightly above the shaft. With this arrangement, the amount of metal in the air gap of A is always practically the same, while the amount of metal in the air gap of B depends on the position of the disk. When magnet B becomes relatively stronger than A, owing to low frequency, the disk turns toward the left and the amount of metal in the air gap of B, and consequently the torque of B, gradually decrease until the torques of the two magnets balance, when the disk stops. When magnet B becomes relatively weaker than A, owing to high frequency, the disk turns toward the right, and the amount of metal in the air gap of B and consequently the torque of B gradually increase until the torques of the two magnets balance, when the disk stops. For every frequency there is a definite point at which the disk comes to rest.

As actually constructed, the edges of the disk are not true circular arcs. The shape is determined experimentally, so that a uniform scale will result.

NEWS NOTES

INCORPORATIONS.

PORTLAND, ORE.—Articles of incorporation have been filed for the Hurley Hydraulic Power Transmission Company. Incorporators: W. J. Binns of San Francisco, and J. H. Hurley and Alexander Sweek of Portland. Capital $50,000.

OLYMPIA, WASH.—With the total capitalization of $1,500,000 and naming as its object the building of an interurban line from Seattle to Tacoma and then to Olympia, articles of incorporation of the Seattle-Tacoma-Oympia Railway Company has been filed. Seattle is named as the principal place of business. Either electrical power, compressed air or steam may be used in operating. The trustees are: W. D. Hall, J. S. Wheeler and S. L. Cravens of Seattle.

ILLUMINATION.

SUMPTER, ORE.—The electric light plant of the Northwestern Light & Power Company was recently destroyed by fire. Loss approximately, $10,000.

VENICE, CAL.—The Pneumatic Power Company, with offices in the Security Building, Los Angeles, has applied for a 50-year franchise to install a water, gas and electric light plant in Venice.

SAN RAFAEL, CAL.—Sealed bids will be received up to September 5th, for the installation and maintenace of poles, wires and other accessories for a street lighting system for the Fairfax lighting district.

BUTTE, MONT.—The Chamber of Commerce, this city, approves the plan of the City Council for providing a lighting system and has pledged its support. Approximately 366 lights, costing $37,175, will be installed.

VAN NUYS, CAL.—By vote the citizens have decided to form the Van Nuys Highway Lighting District. One plan suggested contemplates the erection of ornamental poles with clustered lights throughout the entire 16 miles of boulevard.

PALO ALTO, CAL.—Bids for the concrete building for the water and light plant here, recently received, were: C. A. Bates, San Jose, $15,785; J. M. White Co., San Francisco, $25,500; R. O. Summers, San Jose, $27,699; Bluxome & Co., San Francisco, $28,500. White & Co. presented two alternative propositions— one with modification of the truss roof for $25,250, and one with portion of the walls to be constructed of brick, $24,000.

NEWPORT, CAL.—An election has been called for September 10 for the purpose of submitting the question of incurring bonded indebtedness for acquisition and construction of municipal light works. The proposition is to incur $25,000 bonded indebtedness for the acquisition and construction of generators, retainers and holders for creating and storing electrical energy and necessary buildings, also a distribution system. Bonds to the amount of $39,000 are to be issued for the acquisition and construction of generators, holders, for making, generating and storing illuminating gas and necessary buildings and all necessary distributing systems, consisting of pipes and conduits and all other machinery.

TRANSMISSION.

SAN BERNARDINO, CAL.—According to reports the Southern Sierra Power Company is to add a third unit to its great electrical plant in this city.

SUMPTER, ORE.—The Eastern Oregon Light & Power Company of Baker is at present establishing a power line into this city for the purpose of furnishing power to the Powder River dredge being built here.

ALVISO. CAL.—Work has begun on the $25,000 sub-power station which is to be located some three miles from this city. The Sierra & San Francisco Light & Power Company has material on the ground for the 24 big steel towers.

NAPAVINE, WASH.—The Independent Electric Company has asked the Lewis County Commissioners for a franchise to operate a power line through this place. The old line on the military road in the southern part of the county is to be changed to the C. E. Leonard road to supply Winyock, Little Falls and Castlerock with current.

BAKERSFIELD CAL.—Whether or not the Standard will will pipe its gas to San Francisco Bay is the question that some are asking. The big company has millions and millions of cubic feet in Buena Vista Hills and throughout the Midway District and a great deal more can be obtained through surrounding properties. The Midway Gas Company that is to supply Los Angeles with gas, is buying from the Honolulu Consolidated and also seeking wells for itself. The Standard's gas is still free and the amount used in Bakersfield is insignificant.

TRANSPORTATION.

SALEM, ORE.—Work of clearing the right of way for the electric road from here to Stayton will commence in a few days. The road will be 20 miles long.

RIALTO, CAL.—Bids will be received up to October 1 for a franchise granting right to construct a double track street and interurban railway for a period of 50 years through the city of Rialto.

INDEPENDENCE, ORE.—An electric line is to be built from this place to Buena Vista, work to be begun at once. H. Hirschberg, president of the Independent & Monmouth Railroad, is authority for the statement.

SPOKANE, WASH.—J. H. Young, president, is authority for the information that the Spokane & Inland Empire Railway, will soon construct an extension of the line from Millwood to Newman Lake, Idaho. Surveys are being made.

VANCOUVER, WASH.—Work will begin on the Sifton-Hockinson extension of the Washington-Oregon Interurban line and it is expected to be completed long before the allotted time, January 1, 1913. Lotter & Company are the engineers.

GLENDALE, CAL.—The Glendale & Verdugo Park Railway Company will soon begin active operations, all stock having been subscribed and the money necessary having been paid in. Engineers are now engaged in the preliminary work.

SANTA BARBARA, CAL.—W. H. Brackenridge, vice-president of the Southern California Edison Company, and H. W. Dennis, chief construction engineer of the company, are going over plans for the construction of a street railway in this city.

TACOMA, WASH.—Plans for a municipally owned street car line and bridge across the new Eleventh street bridge, running from A street to River street and Puyallup avenue, and with possibly a branch across the Puyallup river, are being discussed here.

MODESTO, CAL.—The board of directors of the Modesto-Empire Traction Company have decided to purchase a locomotive to haul the road's rapidly growing freight shipments. The directors are also planning to equip the road with electric storage battery cars.

LEWISTON, IDAHO.—The Nez Perce & Idaho Railroad Company, of Nez Perce, will commence surveys at once across the Craig mountains from Forest to Waha and through the Tammany section to Lewiston in preparation for the electric railroad which is to be built.

LOS ANGELES, CAL.—At a recent meeting of the executive committee of Good Government Organization, it was resolved that the city build a double three-rail street car track on San Pedro street, from Aliso to Sixth, for immediate relief of the congestion of street railway traffic.

WILMINGTON, CAL.—The Pacific Electric is rushing construction on the big grade along the water front and will soon have it completed so that trains can run around the bay. South of this grade the Wilmington Transfer Company is building a bulkhead to hold the dredged material.

CLE ELUM, WASH.—S. R. Justham, superintendent of the Salmon Le Sac project of the Kittitas Electric Railway & Power Company, is the authority for the statement that actual work on the line that is to connect this city and Roslyn will be begun within less than a week. According to his statements $15,000 will be expended and a force of 1000 men be given employment.

LOS ANGELES, CAL.—A conference was held recently between a delegation of property owners and W. E. Dunn, managing director of the Los Angeles Railway Company, relative to the proposed car line in South Main street, between Thirty-sixth Place and Slauson avenue. The property owners agree to pay the company's share of paving the street if the company puts in the car line.

SAN FRANCISCO CAL.—Action looking to the immediate extension of the Geary street municipal road from Kearny street down Market to Sansome, where it is to be connected with the outer Market street tracks to provide for a through service to the ferry station, has been taken by the Supervisors. On recommendation of the public utilities committee, the board approved plans and specifications prepared by the Board of Works for the Market street extension and ordered the Board of Works to advertise immediately for bids.

LOS ANGELES, CAL.—At the request of representatives of the Municipal League the Council deferred action one week on the ordinance granting the Pacific Electric Company a 21-year permit to haul freight over its lines in the industrial district east of Los Angeles street. Attorney J. A. Anderson, who appeared as spokesman for the committee representing the Municipal League, said that action should be deferred so that all possible light might be thrown upon the provision of the proposed ordinance. He maintained that the city should be given the power to re-route the cars and maintained that the ordinance should contain an indeterminate provision as to the life of the permit. Councilman Reed said that the freight carrying permit was worth half a million dollars.

TELEPHONE AND TELEGRAPH.

ARLINGTON, WASH.—The Chamber of Commerce is promoting a farmers' telephone line from here to Darrington.

CUTBANK, MONT.—A move has been started for the establishment of a rural telephone system here, to go into the more populated districts.

ST. MARIES, IDAHO.—St. Maries is to have a new telephone exchange costing $9000. J. W. Fisher, manager of the Interstate Telephone Company, has completed plans for the work.

WATTS, CAL.—Bids will be received up to September 17th for a franchise granting the right to operate for 21 years a telephone and telegraph system along the highways of this city.

ILO, IDAHO.—The Pacific States Telephone Company has planned to invest $2000 in Ilo in a modern and up-to-date plant. The improvements include a copper circuit direct to Lewiston.

GLENDORA, CAL.—Sealed bids will be received up to September 3 for a franchise granting the right to maintain for 50 years poles and wires for carrying on a general telephone and telegraph business in this city.

PRESCOTT, ARIZ.—The acquisition of the Overland Company by the Mountain States Telephone Company, will, when connections are made, greatly increase the scope of telephonic service. In Arizona connections will be made with Flagstaff, Holbrook and Winslow.

SEATTLE, WASH.—The county equalization board has refused to reduce the assessment of the Pacific Telephone & Telegraph Company on account of the revocation of the franchise of the Independent company by the City Council, shortly after the two companies were merged. The Pacific company has been assessed $2,471,000 on its tangible property and franchises, and asked that this be reduced to $2,211,182. The Pacific franchise alone was valued last year at $282,615. The combined franchises were valued this year at $459,818. The Pacific company contends that when the Independent plant was taken over last spring the value of the Independent franchise ceased to exist.

EDMONTON, ALBERTA.—Official announcement was made by W. H. Harmer, deputy minister of railways and telephones for the province of Alberta, at Edmonton on August 9 that the government telephone construction program, including the stringing of more than 1500 miles of main lines and the installation of several thousand instruments, will be completed before the end of the year. Twelve hundred men are at work in the various districts. The new copper circuit between Edmonton and Calgary, 198 miles, will be completed early in September and the department will be in a position to handle the business between the two cities for several years to come. Three direct circuits will be in use between Edmonton and Calgary, two of these being copper circuits and the third a "phantom" circuit, formed by the combination of the other two lines. The new circuit from Edmonton to Athabasca Landing, 90 miles, is nearing completion and before fall is far advanced the new service will be in use. The line from Edmonton to Tofield, 40 miles; has been completed. The Tofield-Viking circuit, 41 miles, also is in operation. Other lines which will greatly improve the service between the large and small towns of northern Alberta are being rapidly rushed forward. Lines will be finished this season between Camrose and Tofield, 41 miles; between Camrose and Vegreville, 47 miles; between Camrose and Sedgewick, 44 miles. From Hardisty to Provost, 47 miles; and new lines from Castor to Coronation, 22 miles; are under construction. The line from Castor to Stettler, 34 miles, is completed. Circuits are being installed along the Vegreville-Calgary branch of the Canadian Northern Railway, 180 miles, and along the Tofield-Calgary branch of the Grand Trunk Pacific Railway, 198 miles. The new construction extends from Camrose to Calgary by way of Stettler, 156 miles, along the right of way of the Canadian Northern road, and from Camrose to Calgary, 151 miles, along the Grand Trunk Pacific road. On the main line of the Grand Trunk Pacific, east of Edmonton, local circuits are being installed to relieve the traffic on the main circuit. These local services will give telephone connection between Kinsella and Wainwright, 42 miles, and between Tofield and Viking, 42 miles. Circuits are being installed from Calgary south to High River, 49 miles; from Calgary to Cochrane, 42 miles, and from Calgary to Medicine Hat, 175 miles. The copper circuit between Calgary and Medicine Hat will be completed and in operation in September. Other lines are being built to take care of local business between Calgary and Bassano, 75 miles, and Bassano and Brooks, 42 miles. The lines from Calgary to Carstairs, 40 miles, from Calgary to Red Deer, 95 miles, from Calgary to Airdrie, 41 miles and from Calgary to Acme, 43 miles, will be ready before the end of the year. The new line from Carmangay to Lethbridge, 87 miles, was opened recently, giving a second circuit between the two points. On the Crow's Nest line in the Rockies a number of new circuits, to take care of local business, are under construction and will be completed this season.